Extending free-living gait analysis: A pilot study towards multi-modal sensing

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Background

Technologies are used to digitalise human walking (gait) using quantitative data. Motion capture systems, instrumented walkways and force platforms are perceived as the reference standards but are costly and have low accessibility. Wearable devices (inertial measurement units, IMUs) are effective and affordable to assess gait with additional advantages such as use during free-living. IMUs enable free-living conceptual gait models, used to ease the understanding of the complexities in neurological gait assessment. They detail gait domains (e.g. pace) with subcategories of spatial-temporal characteristics (e.g. step time). However, current models are limited to IMU-based data only.

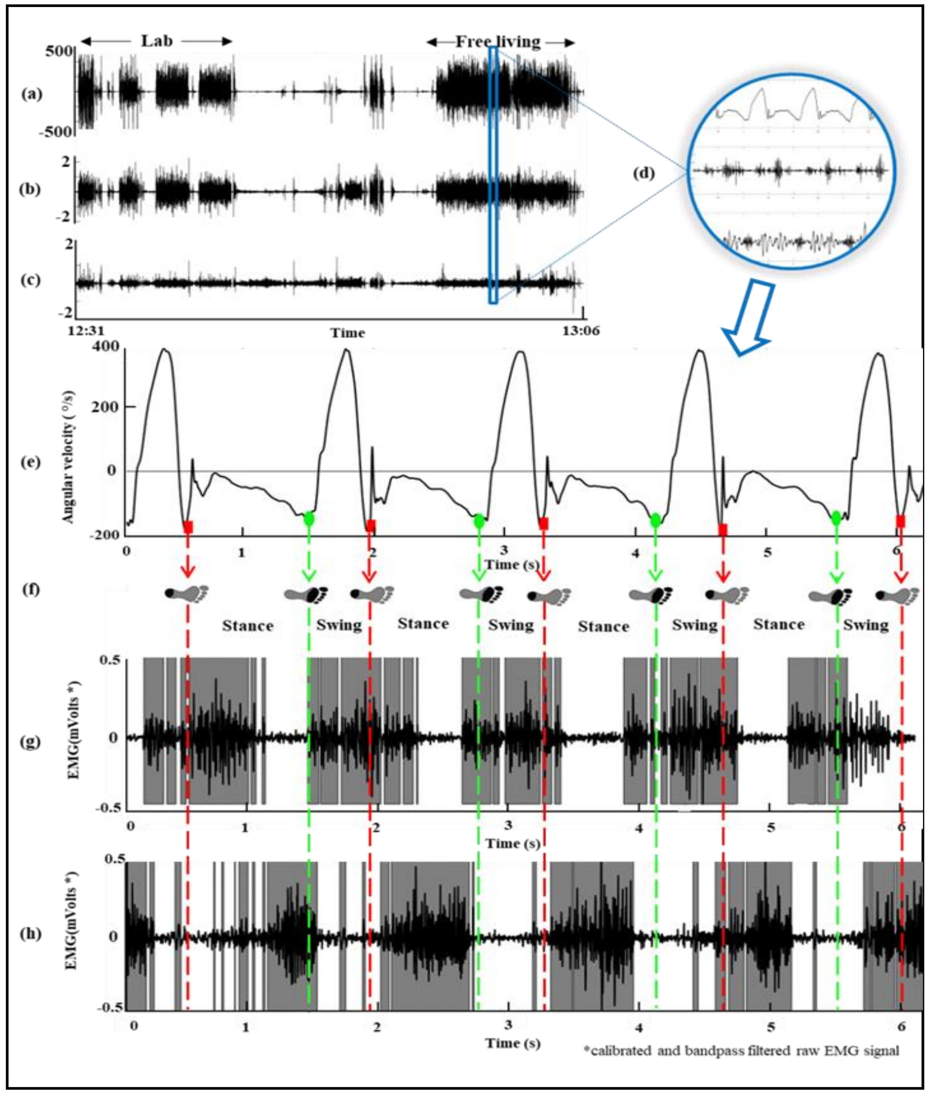
Aim

To improve current conceptual gait models using multi-modal wearable sensing.

Methods

Older adults with stroke gait were recruited from a community group in Byker, Newcastle. Northumbria University Research Ethical Committee approved the study and all participants provided informed written consent. IMU and electromyography (EMG) data were captured using the Shimmer EMG device. Initial contact (IC) and final contact (FC) events were extracted using a prominent methods which uses wavelet approximations. [1]. Muscle onset/offset timings were extracted using K-means clustering as implemented in [2].

	Subject	Strides	Stride (s) Mean (SD)	Stance (s) Mean (SD)	Swing (s) Mean (SD)
Lab	1	12	1.27 (0.05)	0.80 (0.07)	0.47 (0.04)
	2	12	1.03 (0.2)	0.61 (0.03)	0.42 (0.02)
	3	12	1.21 (0.09)	0.81 (0.08)	0.40 (0.06)
Outdoors	1	230	1.08 (0.05)	0.66 (0.06)	0.42 (0.04)
	2	230	1.04 (0.04)	0.61 (0.04)	0.43 (0.05)
	3	230	1.35 (0.06)	0.87 (0.06)	0.48 (0.06)



Results and discussion

Three older adults (3M, >60years) wore the Shimmer on the lower leg. IMU data (Fig.a) were used to identify initial (IC) and final contact (FC) times within the gait cycle (Fig.e) arising in spatiotemporal gait characteristics,Table-1. Subsequently, IC/FC times used to identify sub-phases of the gait cycle(Fig.f). Then, on/offset times of the muscle activities within the gait cycle were investigated in calibrated and bandpass filtered raw EMG signals of Tibialis, TA (Fig.b) and Gastrocnemius, GS (Fig.c), and notable changes observed in terms of burst timing and amplitude for both TA (Fig.g) and GS (Fig.h) . Findings suggest certain EMG patterns are associated with spatiotemporal gait characteristic and may be important targets to augment and improve wearable-based conceptual gait models.

References

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